horological technology, is a noteworthy characteristic. The courses of work in this as well as the other subjects show that sound instruction in the principles and practice of the chief branches of engineering can be obtained at the Institute.

SCIENTIFIC SERIALS.

American Journal of Science, July.—Energy of kathode rays, by W. G. Cady. This is a translation of a paper already published in the *Annalen der Physik*.—Volcanic rocks from Temisconata Lake, Quebec, by H. E. Gregory. The volcanic rocks consist of fine tuff and coarse amygdaloidal conglomerate or breccia. They are interbedded with Niagara sediments, and this helps to determine the time when widespread volcanic activity gave rise to the numerous small areas of tuffs and lavas in the Maine-Quebec region.—Interpretation of mineral analyses, and a criticism of recent articles on the constitution of tourmaline, by S. L. Penfield. It is safe to assume that the close approximation of atomic ratio to whole numbers constitutes the strongest argument that can be advanced in support of the excellence of an analysis and to correctness of the derived formula. The author criticises the formulæ proposed by Clarke and Tschermak, and maintains that it is definitely proved that the empirical formula of the tourmaline acid is $H_{20}B_2Si_4O_{21}$.—Carboniferous boulders from India, by B. K. Emerson. The author describes and illustrates some striated carboniferous boulders which remove the doubt as to the former existence of a carboniferous glacial period.—The statement of rock analyses, by H. S. Washington. The author proposes a regular system of stating the results of the chemical analysis of rocks. The oxides are to be enumerated in the following succession: SiO_2, Al_2O_3, Fe_2O, FeO, MgO, CaO, Na_2O, K_2O, H_2O, CO_2, and then the rarer oxides, also in definite succession. This will enable the geologist to classify the rocks in a purely chemical system and to pick them out at a glance. They can be advantageously entered upon a card catalogue.—A string alternator, by K. Honda and S. Shimizu. The authors describe a modification of Pupin's string interrupter by means of which a continuous battery current can be converted into an alternating current the frequency of which can be readily varied from 30 to 1000 per second.—Action of light on magnetism, by J. H. Hart. The author failed to obtain the demagnetisation of iron by light acting magnetically like an alternating current, until he adopted the expedient of depositing very fine iron films on glass. He then noticed a small but distinct difference in the magnetic state of the iron according to the plane of polarisation of the incident light.

Bollettino della Società Sismologica Italiana, vol. vi. 1900–1901, N. 1.—Rules and list of fellows (forty-three national and thirteen foreign).—Vesuvian notices (year 1899), by G. Mercalli. A monthly review of the condition of Vesuvius, with sections on the form and state of the crater, the end of the eruptive phase of 1895–1899, the lavic cupola of 1895–1899, the supposed endogenous elevation of the lavic cupola, and the fumaroles of the lavic cupola and fracture.—On the nature of seismic vibrations, by M. P. Rudski (in French). The author contends that superficial, and probably deep-seated, rocks are not isotropic media, and that earthquake waves consist of vibrations which are not entirely longitudinal or entirely transversal.—Notices of earthquakes recorded in Italy (January 1 to March 14, 1896), by A. Cancani, the most important being the Mexican earthquakes of January 14 and 25, the Greek earthquake of January 22, and distant earthquakes on January 6, 22, and March 7.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 17.—"The Circulation of the Surface Waters of the North Atlantic Ocean." By H. N. Dickson, B.Sc. Communicated by Sir John Murray, K.C.B., F.R.S.

In this paper an attempt is made to investigate the normal circulation of the surface waters of the Atlantic Ocean north of 40° N. lat., and its changes, by means of a series of synoptic charts showing the distribution of temperature and salinity over the area for each month of the two years 1896 and 1897.

The principal conclusions arrived at with reference to the circulation may be summed up as follows:—

(1) The surface waters along the whole of the eastern seaboard of North America north of (about) lat. 30° N., consisting partly of water brought from the equatorial currents by the Gulf Stream, and partly of water brought down by the Labrador current, are drifted eastward across the Atlantic towards south-western Europe, and banked up against the land outside the continental shelf. This continues all the year round, but it is strongest in summer, when the Atlantic anti-cyclone attains its greatest size and intensity; and the proportion of Gulf Stream water is greatest at that season.

(2) The drifts in the northern part of the Atlantic area are under the control of the cyclones crossing it. The circulation set up accordingly reaches its maximum intensity in winter, and almost dies out in summer. In winter the drifts tend to the south eastward from the mouth of Davis Strait, eastward in mid-Atlantic, and north-eastward in the eastern region. In spring and autumn the movement is more easterly over the whole distance, and a larger quantity of water from the Labrador stream is therefore carried eastward.

(3) The water banked up in the manner described in (1) escapes partly downwards, partly southwards, and partly northwards. It occupies the whole of the eastern basin of the North Atlantic, and to the north it extends westward to Davis Strait, being confined below 300 fathoms depth by the ridges connecting Europe, the Faeroes, Iceland, and Greenland. Above that level it escapes northward by a strong current through the Faeroe-Shetland Channel and between Faeroe and Iceland, and by the two branches of the Irminger stream, one west of Iceland the other west of Greenland.

(As it seems desirable that this northerly current should have a distinctive name, it might be well to call it the European stream, and its branches the Norwegian, Irminger, and Greenland streams respectively.)

The strength and volume of the European stream is liable to considerable variation, according to the form and position of the Atlantic anti-cyclone, which causes the amount of banked up water, and the proportions escaping northward and southward, to vary. It is also modified by the strength and direction of the surface drifts in its course. It is, however, always strongest in summer.

(4) The Norwegian stream is by far the largest branch of the European, and it traverses the Norwegian Sea and enters the Arctic Ocean. The warm water thus sent northward melts enormous quantities of ice, and the fresh water derived from the ice moves southward in autumn, chiefly in a wide surface current, between Iceland and Jan Mayen, which may entirely cover other parts of the Norwegian stream. Part of the surface water also comes southward through the Denmark Strait, but the amount is much smaller, probably chiefly because the melting of the ice is slower, and the channel is longer blocked.

The Greenland branch of the European current also causes melting of ice in Davis Strait, but the warm winds from the American continent and the water received from the land are probably more effective in increasing the volume of the Labrador current.

(5) The water from the melted ice is spread over the surface of the North Atlantic during late autumn and winter by the increasing drift circulation, and it is gradually absorbed by mixing with the underlying water.

(6) The circulation described is liable to extensive irregular variations, corresponding to variations in the atmospheric circulation.

May 31.—"Influence of the Temperature of Liquid Hydrogen on Bacteria." By Allan Macfadyen, M.D., and Sydney Rowland, M.A. Communicated by Lord Lister, P.R.S.

In a previous communication we have shown that the temperature of liquid air has no appreciable effect upon the vitality of micro-organisms, even when they were exposed to this temperature for one week (about −190° C.). (*Roy. Soc. Proc.*, February 1; *ibid.*, April 5.)

We have now been able to execute preliminary experiments projected in our last paper as to the effect of a temperature as low as that of liquid hydrogen on bacterial life. As the approximate temperature of the air may be taken as 300° absolute, and liquid air as 80° absolute, hydrogen as 21° absolute, the ratio of these temperatures roughly is respectively as 15 : 4 : 1. In other words, then, the temperature of liquid

hydrogen is about one-quarter that of liquid air, just as that of liquid air is about one-quarter of that of the average mean temperature. In subjecting bacteria, therefore, to the temperature of liquid hydrogen, we place them under conditions which, in severity of temperature, are as far removed from those of liquid air as are those of liquid air from that of the average summer temperature. By the kindness of Prof. Dewar, the specimens of bacteria were cooled in liquid hydrogen at the Royal Institution. The following organisms were employed: *Bac. acidi lactici*, *B. typhosus*, *B. diphtheriae*, *Proteus vulgaris*, *B. anthracis*, *B. coli communis*, *Staphylococcus pyogenes aureus*, *Spirillum cholerae*, *B. phosphorescens*, *B. pyocyaneus*, a Sarcina and a yeast.

The above organisms in broth culture were sealed in thin glass tubes and introduced directly into liquid hydrogen contained in a vacuum jacketed vessel immersed in liquid air. Under these conditions they were exposed to a temperature of about −252 C. (21° absolute) for ten hours. At the end of the experiment the tubes were opened, and the contents examined microscopically and by culture. The results were entirely negative as regards any alteration in appearance or in vigour of growth of the micro-organisms. It would appear, therefore, that an exposure of ten hours to a temperature of about −252° C. has no appreciable effect on the vitality of micro-organisms.

We hope to extend these observations on the influence of the temperature of liquid hydrogen on vital phenomena, and to make them the subject of a future communication, and to discuss their bearing upon problems of vitality.

June 21.—"On the Viscosity of Gases as affected by Temperature." By Lord Rayleigh, F.R.S.

A former paper[1] describes the apparatus by which I examined the influence of temperature upon the viscosity of argon and other gases. I have recently had the opportunity of testing, in the same way, an interesting sample of gas prepared by Prof. Dewar, being the residue, uncondensed by *liquid hydrogen*, from a large quantity collected at the Bath springs. As was to be expected,[2] it consists mainly of helium, as is evidenced by its spectrum when rendered luminous in a vacuum tube. A line, not visible from another helium tube, approximately in the position of D_5 (Neon) is also apparent.[3]

The result of the comparison of viscosities at about 100° C. and at the temperature of the room was to show that the temperature effect was the same as for *hydrogen*.

In the former paper the results were reduced so as to show to what power (n) of the absolute temperature the viscosity was proportional.

	n.		c.
Air	0·754	...	111·3
Oxygen	0·782	...	128·2
Hydrogen } Helium }	0·681	...	72·2
Argon	0·815	...	150·2

Since practically only two points on the temperature curve were examined, the numbers obtained were of course of no avail to determine whether or no any power of the temperature was adequate to represent the complete curve. The question of the dependence of viscosity upon temperature has been studied by Sutherland,[4] on the basis of a theoretical argument which, if not absolutely rigorous, is still entitled to considerable weight. He deduces from a special form of the kinetic theory as the function of temperature to which the viscosity is proportional

$$\frac{\theta^{\frac{3}{2}}}{1 + c/\theta} \quad \text{..... ..... (1),}$$

c being some constant proper to the particular gas. The simple law $\theta^{\frac{3}{2}}$, appropriate to "hard spheres," here appears as the limiting form when θ is very great. In this case, the collisions are sensibly uninfluenced by the molecular forces which may act at distances exceeding that of impact. When, on the other hand, the temperature and the molecular velocities are lower, the mutual attraction of molecules which pass near one another increase the number of collisions, much as if the diameter of the spheres was increased. Sutherland finds a very good agreement between his formula (1) and the observations of Holman and others upon various gases.

If the law be assumed, my observations suffice to determine the values of c. They are shown in the table, and they agree well with the numbers for air and oxygen calculated by Sutherland from observations of Obermayer.

"Underground Temperature at Oxford in the Year 1899, as determined by Five Platinum Resistance Thermometers." By Arthur A. Rambaut. M.A., D.Sc., Radcliffe Observer. Communicated by E. H. Griffiths, F.R.S.

Royal Microscopical Society, June 20.—Mr. Carruthers, F.R.S., President, in the chair.—Mr. G. H. J. Rogers exhibited a modification of the Rousselet compressor, in which two thin indiarubber bands, sunk into grooves, were employed to keep the cover-glass in position, instead of having it cemented, the advantage claimed for this modification being the facility with which a broken cover-glass can be replaced.—Mr. Chas. Baker exhibited an achromatic substage condenser which was a modification of Zeiss's model of the Abbe condenser, the N.A. being 1·0, aplanatic cone 90°, lenses $\frac{7}{10}$-inch diameter, working distance $\frac{4}{10}$-inch. With the front lens removed the condenser is suitable for use with low-power objectives.—A short paper by Mr. E. B. Stringer, on a new projection eye-piece and an improved polarising eye-piece, was taken as read.—A paper by Miss Loraine Smith, on some new microscopic fungi, was also taken as read, the President giving a short *résumé* of it and expressing his opinion that the paper would be an important addition to our knowledge of microscopic fungi. Mr. Bennett said there was one special point with regards to parasitic fungi which might prove to be of considerable practical importance—he referred to the cultivation of fungus parasites on certain insects It had been proposed to do this on the Continent and in Australia and America, with a view of getting rid of insect pests—locusts and others; and if efforts in this direction were successful they might be the means of producing very beneficial and economic results.—The President then read a paper, and gave a lantern demonstration, on the structure of some palæozoic plants. He said the intelligent study of palæozoic plants was not yet a century old, for although their presence had long been noticed, they appear to have been regarded simply as freaks of nature. The importance of fossils was first recognised by Wm. Smith, who observed that strata could be identified by the organised fossils found in them. He published this important fact in 1816, and thus laid the basis of stratigraphical geology. The majority of fossil plants are found in the shales, and although the tissues had been converted into carbon, the form and venation of the leaves and occasionally the aspect of the fruits had been preserved. The most important information, however, had been obtained from specimens in which the tissues had been replaced by minerals dissolved in the strata enclosing them. He had arranged for the lantern sections of plants from the carboniferous system, but before exhibiting them he wished to point out to what group of plants they belonged. The cellular plants, with few exceptions, had been lost. Sir Wm. Dawson found specimens of a remarkable stem in the lower Devonian rocks of Canada, to which he gave the name of *Protaxites*. From a microscopic study of specimens he, the President, was led to publish a paper in the Society's *Journal* in 1872, in which he demonstrated that the stem was that of a cellular plant belonging to the Algæ, a view which was ultimately accepted by Sir Wm. Dawson. Fungal remains had been detected by Alder, and also by himself. The plants which had been certainly determined were vascular plants belonging to the Equisetaceæ, Filices, and Selaginellaceæ, among Cryptogams, and to the Coniferæ, groups which existed in the present flora of the globe, and were represented in the indigenous flora of Britain. The President proceeded to describe the principal characteristics of the fossil and existing forms of the four orders of plants referred to. In illustration of his remarks a number of preparations were shown on the screen.—Mr. Bennett wished to say a few words to elicit an opinion on a matter of great interest.

[1] *Roy. Soc. Proc.*, vol. lxvi. (1900), p. 68.
[2] *Roy. Soc. Proc.*, vol. lix. (1896), p 207; vol. lx. (1896), p. 56.
[3] I speak doubtfully, because to my eye the interval from D_1 to D_3 (helium) appeared about equal to that between D_3 and the line in question, whereas, according to the measurements of Ramsay and Travers (*Roy. Soc. Proc.*, vol. lxiii., 1898, p. 438), the wave-lengths are:

D_1	5895·0
D_2	5889·0
D_3	5875·9
D_5	5849·6

so that the above-mentioned intervals would be as 19·1 : 26·3 [*June 23.*—Subsequent observations with the aid of a scale showed that the intervals above spoken of were as 20 : 21. According to this the wave-length of the line seen, and supposed to correspond to D_5, would be about 5855 on Rowland's scale, where $D_1 = 5896{\cdot}2$, $D_2 = 5890{\cdot}2$, $D_3 = 5876{\cdot}0$.] I may record that the refractivity of the gas now under discussion is 0·132 relatively to air.
[4] *Phil. Mag.*, vol. xxxvi. (1893), p. 507.

He referred to the recent discovery of the mode of impregnation in some of the Cycadeæ by means of active spermatozoids, as in the case of vascular cryptogams. This seemed to suggest the question whether the gymnosperms were not more closely allied to the vascular cryptogams than was usually recognised. Did the evidence of palæontology favour the view that there was a closer affinity to the vascular cryptogams than to the higher section of flowering plants, the angiosperms?—The President said this question deserved careful consideration, but it should be remembered that in these strata they only saw four groups of plants, and that the coniferæ were found alongside the others, and were evidently living at the same period. Brogniart had shown the presence of pollen grains in the apical cavities of fruits which had been preserved in silex. It was not known how these spermatozoids were developed in Salisburia, but if they rendered pollen grains unnecessary, the presence of the pollen in these extinct fruits would be against the idea of including the gymnosperms with the cryptogams.—The President announced that the rooms of the Society would be closed from August 17 to September 17, and that the next ordinary meeting would be held on October 17.

PARIS.

Academy of Sciences, July 9.—M. Maurice Lévy in the chair.—Problem of permanent heating of a sphere by radiation, reduced to the simpler problem of heating the same sphere by contact, by M. J. Boussinesq.—Combustible gases of the atmosphere; sea air. Existence of free hydrogen in the atmosphere, by M. Armand Gautier. By way of completing his previous researches on the impurities in the air of towns, woods and mountains, the author now gives the results of experiments on sea air. In these experiments no carbon compounds could be detected in 100 litres of air, the amount present, if any, being less than 0·03 mgr. per 100 litres; hydrogen was still found, however, to the extent of 1·21 mgr. for the same volume. The amount of free hydrogen thus proved to be present in the air, 2 parts by volume in 10,000, is thus about two-thirds of the carbon dioxide normally present.—On two loci relating to the densities of the liquid and saturated vapour of carbonic acid, by M. E. H. Amagat. In remarking on a recent paper by MM. Cailetet and Mathias, the author points out that the conclusions drawn, although opposed to his own, are obtained from the same set of experimental data. The law of rectilineal diameters, although extremely useful when applied within certain limits, is not a mathematical but an empirical law, derived from experiment, and hence its use as rigidly true seems hardly justified.—The chemical constitution of steel; influence of tempering upon the state of combination of elements other than carbon, by MM. Carnot and Goutal. In manganiferous steels, the state of combination of the sulphur is not altered by tempering, and phosphorus behaves similarly. In steels containing arsenic, the latter is free if the cooling has been slow, tempered steels containing an arsenide of iron, probably Fe_2As.—M. Czerny was elected a Correspondent for the Section of Medicine and Surgery.—On the equations of motion of a wire in any co-ordinates whatever, by M. G. Floquet.—On certain linear partial differential equations of the second order, by M. C. Guichard.—On the instability of certain substitutions, by M. Levi-Civita.—Demonstration of the rotation of the earth by Foucault's experiment with a pendulum 1 metre long, by M. Alphonse Berget. The sensibility of the reading apparatus is increased by viewing the pointer carried by the pendulum in the field of a microscope furnished with cross-wires in the eyepiece. With a pendulum only 1 metre long, the deviation can be clearly observed after four seconds.—On the liquefaction of gaseous mixtures, by M. F. Caubet. The results of experiments upon mixtures of methyl chloride and sulphur dioxide are here given in the form of curves. Two of the curves have the form predicted from theoretical considerations by Gibbs and Konovalow; these experiments being the first to show these points.—On a new type of mercury pump, allowing of a good vacuum being attained rapidly, by MM. Berlemont and Jouard. A drawing of the pump is given, unaccompanied by any explanation. It is claimed for this pattern that it will work with 12 lbs. of mercury, gives a high vacuum automatically, is not easily broken, and contains neither taps nor rubber connections.—On an ammoniacal chromous sulphate, by M. Ch. Laurent. The salt described, which has the composition $Cr(NH_4)_2.(SO_4)_3+6H_2O$ is analogous to the double sulphate of iron and ammonia.—On the preparation of gentopicrine and glucoside from fresh gentian root, by MM. Em. Bourquelot and H. Hérissey. The fresh roots are treated with boiling alcohol as soon as possible after picking, in order to prevent the action of the oxydases of the plant upon the glucoside, 22 kilograms of root giving 250 grams of crystallised gentiopicrine.—Experimental parthenogenetic segmentation in Amphibia and Fish, by M. E. Bataillon. The chemical composition of the medium, in which the eggs are placed, has only a secondary effect. The serum of mammals, whether diphtheritic or not, behaves like an isotonic solution of a salt or sugar; it acts by its osmotic pressure.—Lœb's theory of the chemical fertilisation of the egg, by M. Viguer.—On the cytology of the Hymenomycetes, by M. René Maire.—The experimental origin of a new vegetable species, by M. Hugo de Vries.—Influence of experimental modifications of the organism upon the metabolism of sugar, by MM. A. Charrin and A. Guillemonat.—A new method of measuring stereognostic tactile sensibility, by MM. Ed. Toulouse and N. Vaschide.—Some new facts concerning the subterranean river at Padirac (Lot), by M. E. A. Martel. The work done in 1899 and 1900 has rendered accessible another 400 metres of this underground river.—Combination of the effects of synodic and tropical revolutions of the moon, by M. A. Poincaré.

NEW SOUTH WALES.

Royal Society, May 2.—W. M. Hamlet, President, in the chair.—Annual general meeting. Mr. W. M. Hamlet read an address upon the development of chemistry. Four words of Arabic or Egyptian source were taken as the text or frame work of this address, namely, alchemy, alkali, alkaloid and alcohol. Under the first came a brief review of the most prominent alchemists. The second afforded scope for the derivation of the word denoting the volatile alkali—the alkaline air—ammonia. In the case of the term alkaloid the researches of Fischer were referred to as showing the constitution of such alkaloids as theobromine and caffeine from structural formulæ of uric acid. Under the generic term, alcohol, the fermentation of other substances than those in use for the production of spirits of wine were dealt with. A vote of thanks was passed to the retiring president, and Prof. Liversidge, F.R.S., was installed as President for the ensuing year.

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